Ohio Agricultural Experiment Station

CIRCULAR No. 143

WOOSTER, OHIO, FEBRUARY 1, 1914

THE SAN JOSE SCALE, THE OYSTER SHELL BARK LOUSE AND THE SCURFY BARK LOUSE

By J. S. HOUSER

The three insects considered in this circular are the three scales most commonly found infesting Ohio orchard trees and the ornamentals, or small fruits, of home grounds. At the outset before taking these three insects into detailed consideration, it may be best to say a few words in general concerning scale insects, inasmuch as very few persons seem to understand, first, why they are called scales; second, how plants become in ested with them; third, how the scale spreads from one plant to another; as well as a number of other points which might be enumerated.

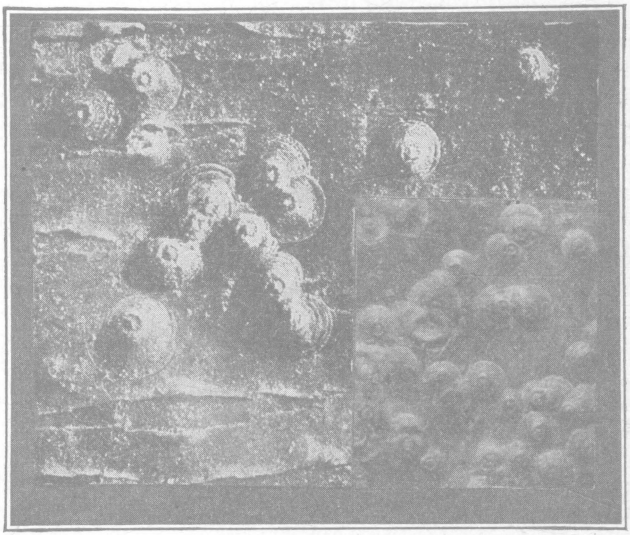

Fig. 1. San Jose scale greatly magnified.

They are called scale insects because each little body is protected by a scale-like covering, or shield. It is not always possible to find the insect proper beneath the scale, for after the young are

produced or the eggs are laid, as the case may be, the body of the mother shrivels away and there is nothing remaining but a tiny, brownish, shrunken, mass. During the winter season, however, one finds beneath the medium-sized, partially grown scales of the San Jose, the yellow body of the partially matured insect, while beneath the scale of the oyster-shell bark-louse one finds a mass of white eggs, and under the scurfy bark-louse a mass of purple eggs. With the coming of summer, the mother San Jose gives birth to living young, and the eggs of the scurfy and oyster-shell bark-lice hatch. The young of all three species are tiny, louse-like creatures, which possess six legs, two eyes, two antennae or feelers, but no wings. The little creatures are quite active and move about freely, seeking a suitable place to establish themselves. This active stage, however, rarely lasts over two days; nevertheless, it is during this period that the pests spread from one part of a tree to another, or from tree to tree. Some of the little creatures crawl to new, uninfested parts of the tree, or fall from the upper to the lower branches; others are carried on the feet of birds, by insects, floating spider webs, or are borne by wind currents.* But no matter in what way the new feeding-ground is reached, as soon as the young scale finds a suitable location, it inserts its sharp, little hair-like beak in the bark of the tree and begins pumping out the sap. Soon the scale begins to form above the body and the insect beneath loses its legs, antennae and eyes, and the body changes considerably in shape. From this time it is powerless to change its location on the tree, with the exception of the males, which appear later and are winged. Thus, we see that the season for spreading is very short, and the facilities within the insect's power for getting about are very limited. Nevertheless, it is remarkable how quickly scales, especially the San Jose, will infest an entire orchard, after once becoming established. Undoubtedly many of the young perish on account of not being able to find a satisfactory feeding-ground. The main reason for the insects being able to spread so rapidly is undoubtedly due to the fact that each female produces a large number of young; and, in the case of San Jose, there are several broods per season. The scurfy bark-louse and the oyster-shell bark-louse each have at least two broods.

THE SAN JOSE SCALE

This is the most harmful of the Ohio scale insects. It is generally distributed over the state, as will be seen from the accompanying maps. Each dot on the map represents an inquiry from the locality indicated, where it is certain that the scale was present, either because specimems were sent, or from some other conclusive evidence.

*It is the belief of Mr. N. E. Shaw, State Inspector of Nurseries and Orchards that wind currents play a very important role in the dissemination of scale insects. Indeed he is inclined to place the importance of this agency above that of all others.

In addition to the inquiries answered by letter, many more have been answered by word of mouth in the entomological office, at the State and County fairs, and at other public gatherings throughout the state; and, as well, many others have been answered from the office of the State Inspector of Nurseries and Orchards, and other sources. Many more cases of infestation occur, of which we have no records, but it is our opinion that the accompanying maps may be considered indicative of the more severely infested centres. The first inquiry answered by letter was in 1895. The first map of the series, Fig. 2, shows the location of the San Jose scale inquiries from 1895 to the end of 1903, in all totaling 91 inquiries. The second map illustrates the location of the inquiries received during the following ten-year period, or until the end of 1913, totaling 1,039 inquiries. It is interesting to note the fact that the positions of the larger cities of the state are indicated as exceptional centers of infestation, an excellent support for the argument that there should be some concerted movement towards insect control in the cities and towns of the state. Undoubtedly the San Jose scale is spreading from year to year, and in some sections, where it has been prevalent for a number of years and no check has been placed on its progress, the trees and shrubs are in a deplorable condition. The preceding illustration, Fig. 1, will give some idea of its appearance when viewed through a strong magnifying glass. As one sees the scales upon the twigs a few scattering individuals have somewhat the appearance of fly specks, but when a twig is encrusted it takes on a dull grayish appearance, commonly described by the statement that it seems covered with wood-ashes.

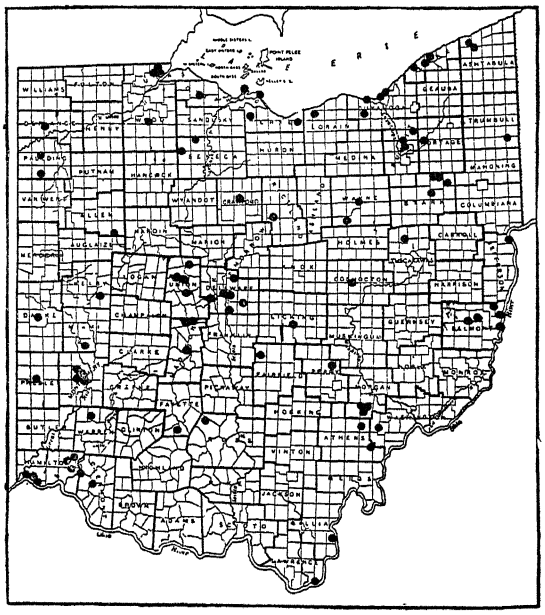

Fig. 2. San Jose scale, reports from 1895-1903 inclusive.

The scale not only infests the twigs and larger branches, but in cases of severe infestation, both the fruit and foliage as well. The result of the work of so many sucking insects is that the tree is literally sapped of its juices and the bark dries up and dies. It may be that the insects are poisonous to the wood as well, for usually the inner portions of the bark are discolored a deep reddish or purplish hue. Small, reddish spots on the fruit are frequently the first indication the farmer has that the trees are infested.

If a tree becomes infested and no assistance is rendered it in overcoming the scale, it either dies in time, or else becomes permanently injured. The degree of injury which the scale inflicts, depends not only on the kind of tree, but on the status of its health as well. Some trees are more hardy than others and will live for years after becoming infested, while some die rather quickly. The peach is rarely able to live more than three or four years after becoming severely infested, while the apple may live for several years. If the trees are weak and puny, they die much sooner than if they are kept in a good, vigorous condition of growth.

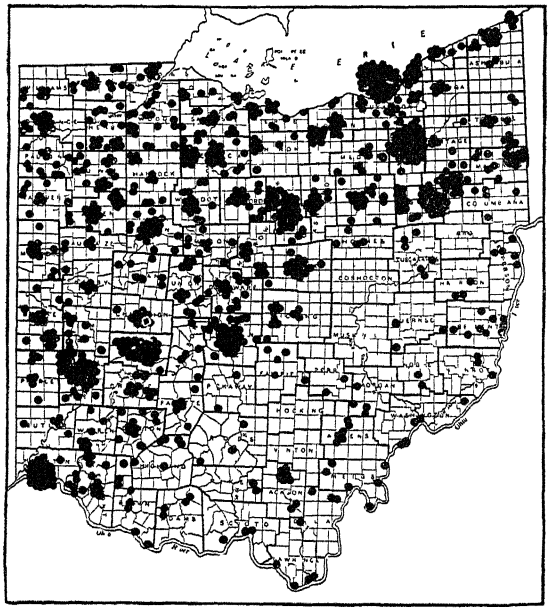

Fig. 3. San Jose scale, reports from 1904-13.

If one is so unfortunate as to get the scale introduced on his premises, hope is by no means gone. Indeed, some are beginning to consider it no calamity at all to have the scale on their trees, since they have found that it may be held in subjection by spraying, and that the cost of the operation is by no means prohibitive. In fact, the general improvement made in the health of the trees usually more than amends for the cost and trouble of the operation.

TREATMENT

The most satisfactory treatment for the San Jose scale is spraying with a good commercial, concentrated lime-sulfur wash in the spring of the year, at the time the buds on the fruit trees are beginning to swell. The concentrated material is usually diluted with water, at the rate of one gallon of the lime-sulfur to 7 gallons of water. See page 59 on "Lime-sulfur mixture." Of course, when one has a large orchard to spray, it is necessary to begin a little earlier than this time, or even to do some of the work the previous fall, in order to finish before the foliage is too far advanced, but it is best to avoid spraying during the winter months, and by no means should the work be done when the temperature is below 32°, or when the trees are wet or partially covered with snow or ice. Sometimes, in the case of severe infestation, it is best to spray in the fall after the eaves are shed, and to follow this treatment with another in the spring, but if one spraying only is to be given, it is best to defer the work until the spring period.

Occasionally, however, the scale is not discovered until the leaves have started in the spring, thus making it unsafe to apply the lime-sulfur with the spray pump except to the lower parts of the trunks. If the trees are infested to the extent that considerable harm will be done during the ensuing summer, it is entirely practicable to paint with a brush the upper parts of the trunk and the larger limbs of the trees, with the lime-sulfur wash at the strength recommended for the spring spraying. If the badly infested limbs well up in the tree are treated in this manner, the progress of the scale will be checked considerably during the summer breeding season.

It is scarcely advisable to attempt to spray the entire tree during the summer months with the idea in mind of destroying the newly born young, since young are appearing almost continuously and it would, therefore, be necessary to make rather frequent applications.

A final point, and a very important one in the control of the San Jose scale, is the destruction of all worthless trees, or shrubs, which it would not be profitable to save. It is also advisable in the case of badly infested large trees to prune severely, especially with regard to lowering the top, before the spraying is commenced. This, together with the removal of all dead and useless wood, will much facilitate the application of the material.

THE SCURFY BARK LOUSE

This scale insect is dirty-white in color and an infested tree presents the appearance of having small bits of dirty tissue stuck to the bark. The individual female scales are a little larger than the head of an ordinary pin and the male scales are smaller, long and narrow. Some idea of the insect may be had from Fig. 4.

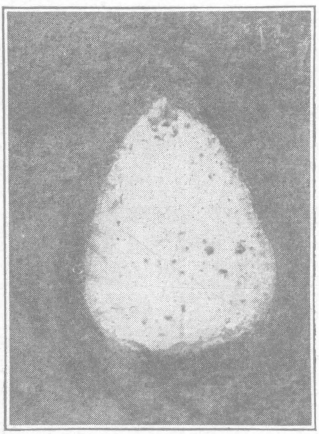

Fig. 4. Scurfy scale, female, much enlarged.

The pest is a native of this country, occurring not only in the woods upon hawthorn and other trees, but also is to be found in practically every apple orchard in the state. A study of the maps illustrated by Figs. 6 and 7 is very interesting, especially when compared with Figs. 2 and 3. The first record we have of the scale in this state was in 1890, though it was doubtless widely disseminated many years earlier than this. From this date to the close of 1903, 261 inquiries were received, which were fairly well distributed over the state. From 1904 to the close of 1913, 838 inquiries were received, which still farther indicate the general distribution of the species. It will also be noted that the cities do not seem to be the centres of infestation, as is the case with the San Jose.

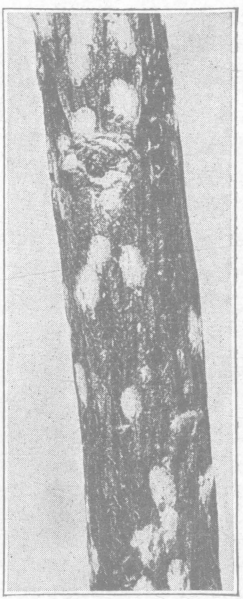

Fig. 5. Scurfy scale enlarged on twig.

Ordinarily, no very great harm results from its presence, but sometimes natural enemies fail to control it, or trees weakened by some other cause, especially those rather newly set, become severely infested and under such conditions require assistance. A few scattering scales probably do little harm, but when the insect becomes thoroughly established, measures should be taken against it.

TREATMENT

The same treatment advised for the San Jose scale is equally effective in combatting this species, viz.: Spray with the

concentrated lime-sulfur wash in the spring of the year before the buds swell. The mixture may be used in the same strength advised for San Jose—each gallon of a 33° Beaume mixture diluted with 7 gallons of water; other strengths diluted according to the tables given on page 50.

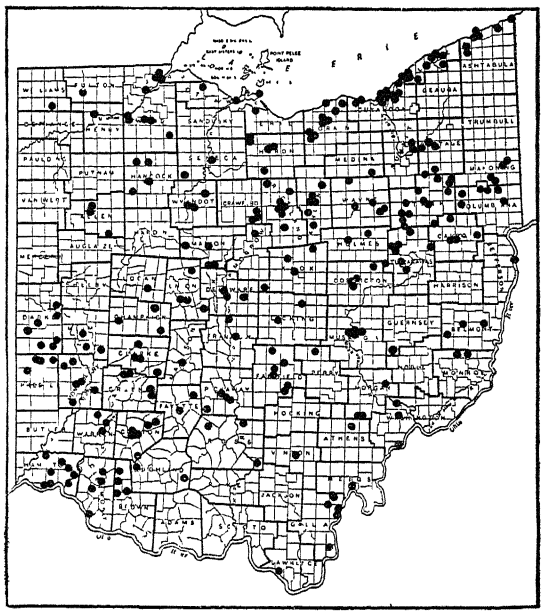

Fig. 6. Scurfy scale, reports from 1890-1903 inclusive.

The home-boiled lime-sulfur or the soluble oils are also effective. It is also practicable to control this scale by summer spraying, since all the young appear within a period of a few days; hence, by watching during late May or in June for the myriads of tiny, crawling young lice, the tree may then be sprayed with a weak material, strong enough to kill the tender insects, without injuring the trees. Kerosene emulsion, prepared after the regular formula and used at the rate of one gallon to 15 gallons of water, is very satisfactory for this purpose.

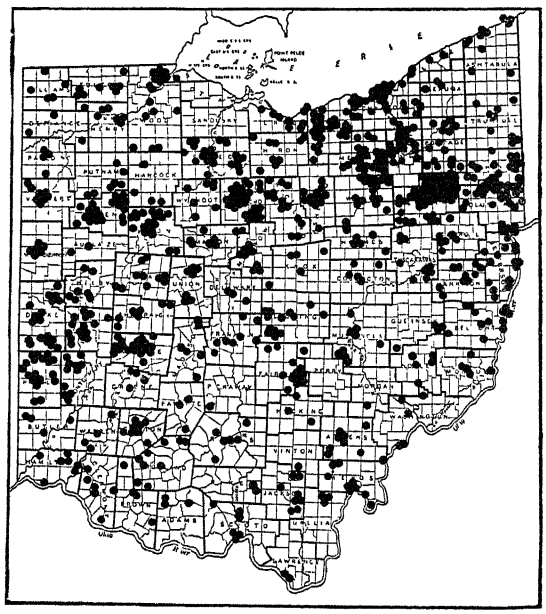

Fig. 7. Scurfy scale, reports from 1904-13 inclusive.

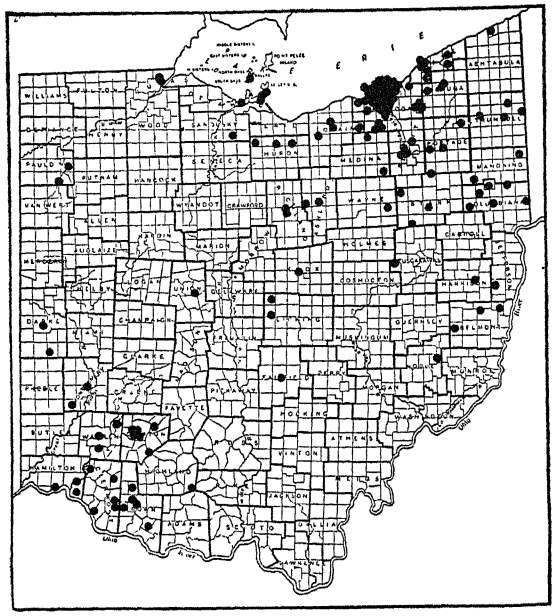

Fig. 8. Oyster shell scale, reports from 1890-1913 inclusive

The writer prefers to consider the summer treatment with kerosene emulsion rather as an emergency treatment, to be employed in cases where the spring spraying has been neglected, since there is some danger from the use of oils and, further, because the lime-sulfur wash is not only safe, but operates against several of the different disease organisms as well as against the scale.

THE OYSTER SHELL BARK LOUSE

This scale insect is, perhaps, the most difficult of the three to combat. Fortunately, however, from the standpoint of the farmer, it must be considered more largely a pest of city plantings than of the farm. A reference to the maps, indicating the distribution of this species, shows its remarkable prevalence in the region of Akron and Cleveland.

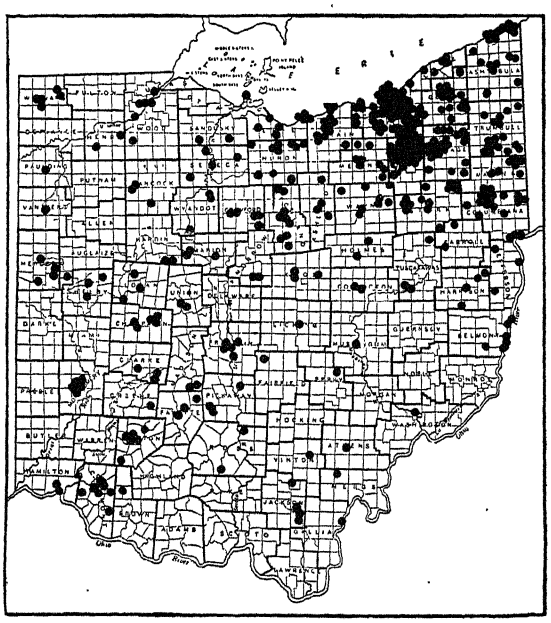

Fig. 9. Oyster shell scale, reports from 1904-13 inclusive.

In general appearance, the scale is dark-brown in color, round and flat at one end and gradually narrowing to a blunt point at the other, and at the same time taking on a bent, or twisted formation. An idea of it may be better secured by examining the accompanying illustrations. The winter is passed in the egg stage, and the eggs themselves are pearly white in color.

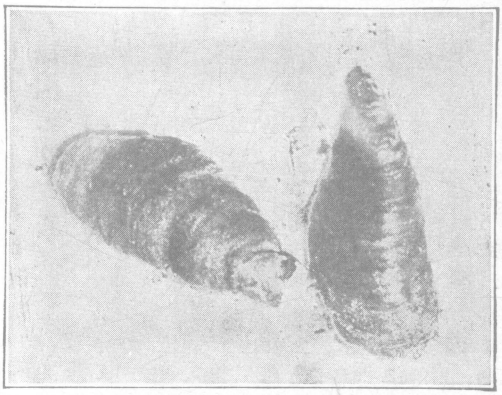

Fig. 10. Oyster shell scale, greatly enlarged.

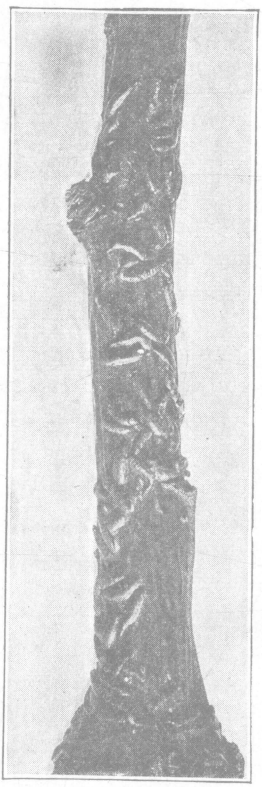

Fig. 11. Oyster shell scale on twig, enlarged.

The principal trees attacked are cottonwood, or Carolina poplar, horse-chestnut and ash. Since the first two have been quite extensively planted during years past in both these cities for securing quick shade in new allotments, the abundance of the species may readily be understood. Cleveland, especially, is now taking drastic measures to decrease the amount of Carolina poplar within its borders, actually cutting down and destroying these trees whenever possible. It must not be understood, however, that the oyster-shell bark-louse is confined to cities, for, occasionally, it becomes destructively abundant on ornamental and shade trees as well as on apples in the country. Young apples which have not become well established are more susceptible to infestation, and such trees are more liable to require assistance.

REMEDIES

As intimated at the outset, this scale is sometimes quite resistant to efforts to control it, due, no doubt, to the fact that the winter is passed in the egg stage and because the scale itself is hard and compact in texture and is quite firmly glued down to the bark of

the host. After years of experiment, the lime-sulfur wash, one gallon to seven of water, applied in the spring just as the buds are swelling, is considered the most satisfactory of all the spraying mixtures, but in the case of very severe infestation, it is occasionally necessary to make several annual applications at the time specified, before the pest is subdued. This applies particularly to instances where the scales are piled one upon another, thus rendering it increasingly difficult for the spraying material to penetrate the mass.

A summer treatment, made at the same time and using the same materials as advised for the scurfy bark louse, is also effective against this species, but, as with the case of the scurfy scale, should be considered as an emergency method of control. Under certain circumstances, however, as in the case of prized plants, the summer treatment is very useful; indeed, may be resorted to as a supplement of the early spring work.

One of the most important factors, however, in the control of this scale, is the destruction of unnecessary trees of the Carolina poplar, horse-chestnut and ash, as well as of the common lilac, since the latter is one of the prolific breeders of this scale

THE LIME-SULFUR WASH

The lime-sulfur wash is now most generally used for the control of the San Jose, and some other species of scale insects, though the soluble or miscible oils are used to a considerable extent in some places. The principal features in favor of the lime-sulphur wash are that it rarely injures trees, and it is an excellent help in destroying over-wintering forms of some other insects, and of rot, or disease organisms. Yet, lime-sulphur has a slight tendency to corrode the working parts of the pump and is liable to burn one's skin.

The soluble oils are, likewise, good destroyers of scale, but while easy on the pump they are exceedingly destructive to hose. Rarely will hose last more than one season when used for oil, and sometimes it will not last the season through.

There are five types of the lime-sulfur wash, all of which are used in orchard work and about which there is no end of misunderstanding. These are as follows:

1. The commercial concentrated liquid lime-sulphur.
2. The home-made concentrated liquid lime-sulfur.
3. The commercial powdered sulphur compound.
4. The home boiled dilute lime-sulphur. (The old-fashioned home-made lime-sulfur.)
5. The home-made self-boiled lime-sulfur.

THE COMMERCIAL, CONCENTRATED, LIQUID LIME-SULFUR

This form of lime-sulphur is the one most commonly used for the control of scale insects, and is applied at the usual rate of 1 gallon diluted with 7 gallons of water in the spring before the leaves appear. It is also used later in the season for apple diseases in a much more dilute form, 1 gallon being mixed with 35 to 40 gallons of water, but in this circular it is considered from the standpoint of a scale destroyer. A large number of firms manufacture it, a list of which will be furnished upon request.

This commercial concentrated lime-sulfur is a heavy liquid, made by boiling together lime and sulphur in water. During the boiling, the lime and sulphur unite and the new product goes into solution and increases the density or weight of the liquid. Thus, if much lime and sulphur are combined, the liquid is strong, and if little are combined, the liquid is weak. The density of the liquid is easily measured by means of a little instrument called a hydrometer, which has somewhat the appearance of a thermometer; when placed in the liquid it stands upright, and all of it is submerged but a part of the stem. The figures on the stem at the surface of the liquid indicate the strength of the solution. The usual type of hydrometer is called the Beaume, hence, when we see the statement or the guarantee that a lime-sulfur mixture tests 33° Beaume, it is readily understood that when this instrument is placed in the mixture it sinks to the 33° mark.

33° Beaume is coming to be generally considered as the standard density for commercial lime-sulphur, but the commercial mixtures have varied greatly in strength and density, and one can be safe only by testing each barrel of solution. A Beaume hydrometer, suitable for this purpose, may be obtained from the Bausch & Lomb Optical Co., of Rochester, N. Y. for $1.25, and such an instrument should be in the hands of every one who is using the commercial lime-sulfur.

The hydrometer test for the density of the liquid is not absolute proof that the solution is first class. The mixture may test 33° Beaume and still be of inferior quality, due in some cases to adulterations. Each gallon of a well-made lime-sulfur, testing 33° Beaume, should contain about 2.7 pounds of sulfur, or, in other words, should contain about 25 percent sulfur.

The new law governing the manufacture and sale of of insecticides and fungicides states that each unbroken package of lime-sulfur must bear a label giving the Beaume reading of the density of the mixture contained therein, as well as the amount of sulfur in

solution. Non-compliance with this law is a punishable misdemeanor, and offenders should be reported to the Agricultural Commission, State House, Columbus, O.

There is much confusion concerning the proper amount of water to be added to each gallon of concentrated lime-sulfur. It is our belief that each gallon of lime-sulfur, testing 33° Beaume, should be diluted with not more than 7 gallons of water. But, if the concentrated solution is weaker, less water should be used. The following table of dilutions is, in our estimation, approximately correct:

If the lime-sulfur solution tests						25°	Beaume,	dilute	each	gallon	with	8	gallons	of water.
"	"	"	"	"	"	34°	"	"	"	"	"	7½	"	"
"	"	"	"	"	"	33°	"	"	"	"	"	7	"	"
"	"	"	"	"	"	32°	"	"	"	"	"	6½	"	"
"	"	"	"	"	"	31°	"	"	"	"	"	6	"	"
"	"	"	"	"	"	30°	"	"	"	"	"	5½	"	"
"	"	"	"	"	"	29°	"	"	"	"	"	5¼	"	"

There has been some dissatisfaction in late years, however, with the commercial lime-sulfur wash, and a considerable number have reported to us ill-success following its use. Just how much of the trouble has been due to faulty mixtures, and how much to improper application, it is difficult to say. Nevertheless, the fact remains that some of our best orchardists have returned to the use of the home-boiled, dilute lime-sulphur—men who know how to spray and who are properly equipped for it, so it seems reasonably certain that the commercial mixtures they used were at fault. Also, as stated previously, it is a well-known fact that the strength of the concentrated solutions has been quite variable.

THE HOME-MADE CONCENTRATED LIQUID LIME-SULFUR

When commercial houses first began the manufacture of a concentrated lime-sulfur solution, the price of the product was rather high and men were stimulated to attempt the preparation of such a product at home. Considerable work of an experimental nature was done at that time by some of the Agricultural Experiment Stations, and methods were developed for the preparation of a product of fair value. However, it was found difficult to procure a product, except where specially prepared apparatus was used, that was not variable in density; this being due in part to the meagre facilities to be had on the ordinary farm. Likewise, it was inconvenient to remove all the sediment, as has been the custom in the manufacture of the commercial product. In view of these difficulties, as well as of the fact that, meantime, the competition of commercial concerns has reduced perceptibly the cost to the consumer, it is now generally considered as being scarcely worth while to attempt the saving of the small margin possible by preparing the material at home.

THE COMMERCIAL POWDERED SULFUR COMPOUND

This product is of recent origin. It is a dry powder which is mixed with water and sprayed on the trees. It is intended by its promoters to replace the commercial concentrated lime-sulfur. It appeals strongly to the intending user on account of the saving in freight which its use makes possible. Its efficiency in controlling scale is by no means so thoroughly established as is that of the regular commercial concentrated liquid, and it seems advisable to be cautious in placing absolute dependence upon it.

THE HOME-BOILED DILUTE LIME-SULFUR

This form of lime-sulfur is the one first used for the control of scale insects. It is prepared by boiling together 15 lbs. lime, 15-20 lbs. sulfur, and 15-20 gallons of water. Boiling is continued for about 45 minutes to one hour, and at the end of this time enough water is added (preferably hot) to make 50 gallons in all. It carries with it a considerable amount of sediment and works most satisfactorily when applied hot. If allowed to stand more than 36 to 48 hours crystals are liable to form, which detract from the value of the wash. The amount of lime given in the formula is in excess of that required for the chemical combination of the lime and sulfur. The abundance of the lime colors the mixture, however, and thus acts as a marker which aids materially in indicating the parts of the tree covered with the spray.

While inconvenient to prepare, the fact remains that the results following its use have been generally satisfactory. In fact, some of our best orchardists have returned to the use of this wash after having used the commercial concentrated product for a number of years.

Complete directions for its preparation are given in Bulletin 169, Ohio Agricultural Experiment Station.

THE HOME-MADE SELF-BOILED LIME-SULFUR

This lime-sulfur mixture is prepared by mixing the sulphur with water, and after the lump lime has been started to slake, the sulfur, wet with water, is thrown upon the lime. The heat from the slaking lime is sufficient to cause a partial combination of lime and sulfur. See Bul. 232, Ohio Agricultural Experiment Station, for complete directions for its preparation.

This mixture is at present used mainly as a summer spray for the control of fungus troubles of peach and plum; hence, it needs no further comment at this time.

SUMMARY

1. The three scales considered in this circular are liable to occur in any orchard, since all are fairly well distributed over the state. The San Jose kills more orchard trees than any other orchard pest.

2. All may be destroyed by spraying in the spring of the year, about the time the buds are swelling, with the lime-sulfur wash, using the standard, commercial, concentrated solution at the rate of one gallon diluted with 7 gallons of water, or the home-boiled, dilute lime-sulfur, made according to the formula approved in this circular

3. The new law requires each unbroken package of lime-sulfur to bear a label, giving the degree of concentration and the percent of sulfur of the contents. Look for this label and report any non-compliance to the Agricultural Commission, State House, Columbus. Ohio.

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